COULOMB ENERGIES IN ISOBARIC MULTIPLETS

M. A. Bentley
School of Chemistry and Physics, Keele University, Keele, Staffordshire ST5 5BG. U.K.

One of the most basic of the fundamental symmetries in nuclear physics is the exchange symmetry between the neutrons and protons in the nucleus which can be described by the isospin quantum number, T. In the absence of a Coulomb force, the assumption of a charge-independent and charge-symmetric nuclear force implies that states of the same isospin in a set of nuclides of the same mass number (isobaric analogue states) will be degenerate in energy. The Coulomb force, of course, will lift this degeneracy with the effect that the excitation energies of the excited isobaric analogue states will show slight differences associated with the subtle influence of the Coulomb force.

Detailed studies of isobaric multiplets (such as mirror nuclei) in the $A \approx 50$ region have now established that Coulomb energy differences (CED) between excited states of isobaric multiplets can be reliably interpreted at the 10's of keV level in terms of detailed and varied nuclear structure effects. These spin-dependent phenomena include changes in spatial correlations of valence protons (e.g. rotational alignments) and band-termination effects [e.g. 1,2,3], changes in bulk deformation and/or radii [4,5] and the electromagnetic spin-orbit interaction [6]. In a recent study [7] of the $A = 53$ mirror nuclei, $f_{\frac{7}{2}}$ Coulomb matrix elements were extracted, which show an anomalous behavior – and this effect now appears to be prevalent across the shell. A key advantage of performing these studies in the $f_{\frac{7}{2}}$ region comes from the availability of full-pf shell model calculations. Shell-model calculations have been modified to include both multipole (e.g.[4]) and monopole (e.g. [5,8]) Coulomb terms. Thus this work provides an extremely stringent test of the model and, conversely, the reliability of the model provides a valuable tool in the interpretation of the measured Coulomb effects in terms of nuclear structure phenomena. A review of the current status of these studies will be presented.

In a recent experiment using the RISING spectrometer at GSI, the technique of relativistic two-step fragmentation for populating and identifying excited states in light proton-rich nuclei was investigated. The latest results from the ongoing analysis will be presented.

[1] J.A. Cameron *et al.*, Phys. Lett. **B235** (1990) 239
[2] C. D. O'Leary *et al.*, Phys. Rev. Lett. **79** (1997) 4349
[3] M.A. Bentley *et al.*, Phys. Rev. **C62** (2000) 051303R
[4] M.A. Bentley *et al.*, Phys. Lett. **B437** (1998) 243
[5] S.M. Lenzi *et al.*, Phys. Rev. Lett. **87** (2001) 122501
[6] J. Ekman *et al.*, Phys. Rev. Lett. **92** (2004) 132502
[7] S.J. Williams *et al.*, Phys. Rev. **C68** (2003) 011301R
[8] A.P. Zuker *et al.*, Phys. Rev. Lett. **89** (2002) 142502